UNC-Chapel Hill DCRP Best Master's Project of 2010

Town of Chapel Hill Greenhouse Gas Emissions Annual Inventory

Municipal Operations: 2005 Through 2009

Brian C. Callaway

In 2006, the Town of Chapel Hill committed to a 60 percent reduction in greenhouse gas emissions from municipal operations by 2050. Having not conducted a baseline study prior to this commitment, the Town commissioned the author to create a 2005 baseline inventory of greenhouse gas emissions. This Master's Project achieved that goal and added annual inventories through 2009. The Town of Chapel Hill anticipates that this information will be used to guide initial greenhouse gas emission reduction measures to help meet its 2050 goal.

Editors' Note: Portions of this feature have been edited or cut due to space considerations. If you are interested in reading the original, full-length document, please contact carolinaplanning@unc.edu.

Introduction

The scientific evidence of climate change is now well established and necessitates immediate local and global action. In order to successfully manage greenhouse gases, it is imperative that emissions are accurately measured. A high-quality inventory identifies all emission sources, can inform decision makers, and will monitor reduction progress.

This report is the first comprehensive greenhouse gas inventory of municipal operations and represents the most assertive carbon reduction action yet taken by the Town of Chapel Hill, North Carolina (the Town). It covers five calendar years from 2005 to 2009, with data reported annually, and now gives the Town the confidence to move forward towards its goal of reducing greenhouse gas emissions by 60% by the year 2050.

This report is intended to be a foundation for all future Town greenhouse gas inventories. Detailed explanations are offered on an array of topics from the current scientific knowledge of climate change, to the intricacies of carbon accounting, to the methodology of each step. This level of detail is necessitated by the fact that this report includes the 2005 baseline of greenhouse gas emission measures, which will likely be referenced by all future reduction targets.

Climate change, although a global issue, is still a local matter. Local governments keep the streetlights on, provide transportation services, and shape the character of future growth. Across America, cities are at the forefront of climate change action. More and more local governments are responding to climate change in two ways: 1) mitigating the effects of climate change by reducing greenhouse gas emissions at the local level and 2) planning to adapt to some of the expected results of climate change. This document speaks to the first action item: stopping the bleeding.

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Details on Global Warming

The U.S. Environmental Protection Agency reports that scientific evidence has determined that:

- Human activities are changing the composition of Earth's atmosphere
- The atmospheric buildup of greenhouse gases is largely the result of human activities such as the burning of fossil fuels
- An "unequivocal" warming trend of about 0.56°C to 0.92°C occurred from 1906 to 2005
- The major greenhouse gases emitted by human activities remain in the atmosphere for periods ranging from decades to centuries. It is therefore virtually certain that atmospheric concentrations of greenhouse gases will continue to rise over the next few decades
- Increasing greenhouse gas concentrations tend to warm the planet (U.S. EPA 2009)

The existence of global warming and beginning of climate change is fully supported by climate science. The only debate within the scientific community is about predicting how much and how fast the global temperature will rise. With rising global temperatures and rising carbon dioxide concentrations, a wide range of climate impacts are expected by the Intergovernmental Panel on Climate Change (IPCC), including the following:

- Changes in average regional precipitation with some regions experiencing an increase, others a decrease
- An increase in the intensity of precipitation events that will lead to more floods
- More intense but less frequent tropical cyclones
- Sea-level rise and ocean acidification

An extreme loss of biodiversity, increased human health concerns, and significant disruptions in food chains are likely to occur if climate change continues unabated. Although no official global targets have been set, it is widely accepted that in order to avert dangerous levels of climate change, the earth's average temperature must not rise more than 2°C above pre-industrial levels. It has already risen about 0.74°C. Climate models vary as to predicting what atmospheric carbon dioxide concentrations are necessary to reverse the rising global temperature, but Dr. James Hansen, head of the Goddard Institute of Space Science at NASA and a leading climate scientist, has joined other scientists in calculating 350 ppm as the safe upper limit for carbon dioxide concentrations (Hansen et al. 2008). This mark is notably lower than the average carbon dioxide concentration in 2009 of 387 ppm.

Background

Fossil Fuel Use

Especially since the Industrial Revolution, human activity has been consuming ever-increasing quantities of fossil fuels. According to the U.S. Energy Information Administration, fossil fuels (including coal, natural gas, and petroleum) were the source of over 86% of the world's energy consumption in 2006. These fuels provide the majority of our energy used to produce electricity, operate our motor vehicles, and heat our buildings. Because these fossil fuels have essentially been storing energy and carbon for millions of years below the Earth's surface, our ecosystem had reached a carbon equilibrium that helped shape and support our current climate and biodiversity. Now, as human activity continues to transfer this carbon from fossil fuels to the atmosphere, the natural cycle becomes disrupted and excess atmospheric carbon dioxide builds (see sidebar for more information on climate change). These rising concentrations of carbon dioxide threaten our climate.

Reduction Targets and Local Commitments

In a 2007 report, the Intergovernmental Panel on Climate Change (IPCC) established that in order to achieve a stabilization of atmospheric carbon dioxide that could preserve our current ecosystems, developed countries would have to reduce total greenhouse gas emissions 80% to 95% below 1990 levels by 2050 (IPCC 2007). President Barack Obama and the White House are calling for reductions in the U.S. of 17% below 2005 levels by 2020 and 83% by 2050. On the national scale, President Obama announced in January 2010 that the federal government would set an example for the nation and reduce the greenhouse gas emissions from federal operations 28% below 2008 levels by 2020 (Office of the Press Secretary 2010).

Before these global and national targets were established, the Town of Chapel Hill joined the CRed (Community Carbon Reduction) Project from the United Kingdom in June 2006 and pledged to reduce the greenhouse gas emissions from municipal operations 60% below 2005 levels by 2050. This 60% reduction pledge at the time represented one of the most aggressive municipal pledges in the nation. Interim reduction goals were added to the pledge, including a 5% reduction from 2005 levels by 2010.

The Town has additionally expressed its commitment to environmental sustainability by becoming a member of ICLEI-Local Governments for Sustainability in 2001 and a signatory of the U.S. Conference of Mayors Climate Protection Agreement.[1] The U.S. Conference of Mayors recognized the inaction of the federal government to implement the Kyoto Protocol and subsequently urged local governments to strive to meet greenhouse gas reduction goals and to sign the Climate Protection Agreement. To date, 1,017 mayors have signed the climate commitment.

Other cities in North Carolina have also made pledges to reduce the greenhouse gas emissions from their municipal operations. Those commitments include:

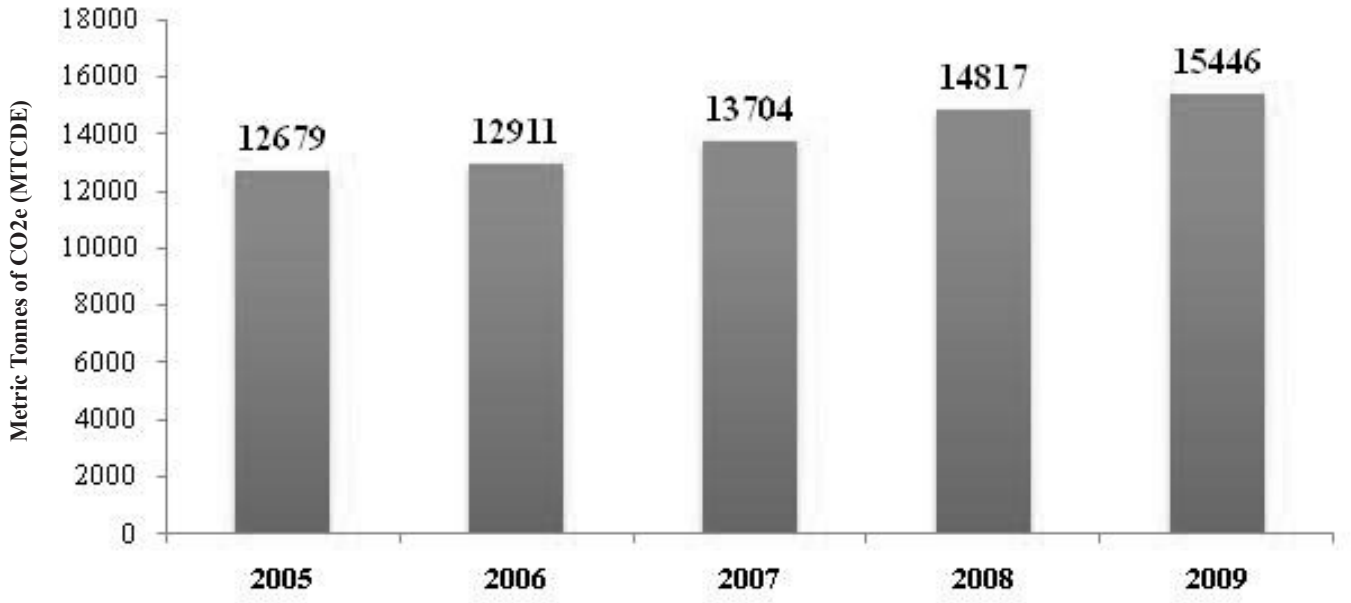

Figure 1: Total Greenhouse Gas (GHG) Emissions from Municipal Operations, 2005 - 2009.

- Asheville: 80% absolute reduction from 2007 levels by 2050
- Durham: 50% absolute reduction from 2005 by 2030
- Winston-Salem: stabilization of emissions by 2010

Greenhouse Gas Inventories

ICLEI-Local Governments for Sustainability has taken the lead in organizing communities to reduce greenhouse gas emissions and has established "Five Milestones" that provide a simple, standardized approach to reaching the goal of climate mitigation.[2]

The first step, achieved by this Master's Project, is to conduct a detailed greenhouse gas inventory for a selected baseline year and a forecast of emissions at a target year. The baseline provides a point by which the Town can compare its achievement over time. Based on data availability and an alignment with pre-established Town and Orange County goals, the baseline for municipal operations from the Town was chosen to be calendar year 2005. The target year, also based on already existing goals, is 2050.

Standard reporting procedure is that greenhouse gas emissions be reported on a calendar year basis, and this report includes annual inventories for each year from the baseline 2005 through 2009. The data from 2009 will be highlighted to showcase the most recent trends. Although there is no standard requirement for the frequency of conducting greenhouse gas inventories, there is exceptional value in reporting emissions on an annual basis in order to closely monitor operations and identify trends.

Greenhouse gas inventorying is a relatively new system of accounting. ICLEI, in partnership with the California Air Resources Board, California Climate Action Registry, and The Climate Registry, has developed a protocol specifically intended for use by municipal governments: *Local Government Operations Protocol, for the quantification and reporting of greenhouse gas emissions inventories, Version 1.0*. As a member of ICLEI, the Town decided to utilize this protocol as its reporting standard. All decisions and calculations within this inventory have been made with the guidance provided by this protocol.

Municipalities are unique entities with regard to greenhouse gas emissions. There are two classes of emissions that municipalities are concerned with: 1) the emissions from municipal operations and 2) the emissions from the community as a whole. This inventory details greenhouse gas emissions from *municipal operations only*. This decision does not in any way overlook the importance of reducing community-wide emissions. It is fully acknowledged that the community-wide greenhouse gas emissions are far greater than those from municipal operations, but municipal operations are securely within the Town's direct control. In an effort to lead by example, the Town will first focus on quantifying their own municipal operations emissions and charting appropriate reduction measures.

[Editors' note: A section on defining municipal operations was excluded from this printing due to space considerations.]

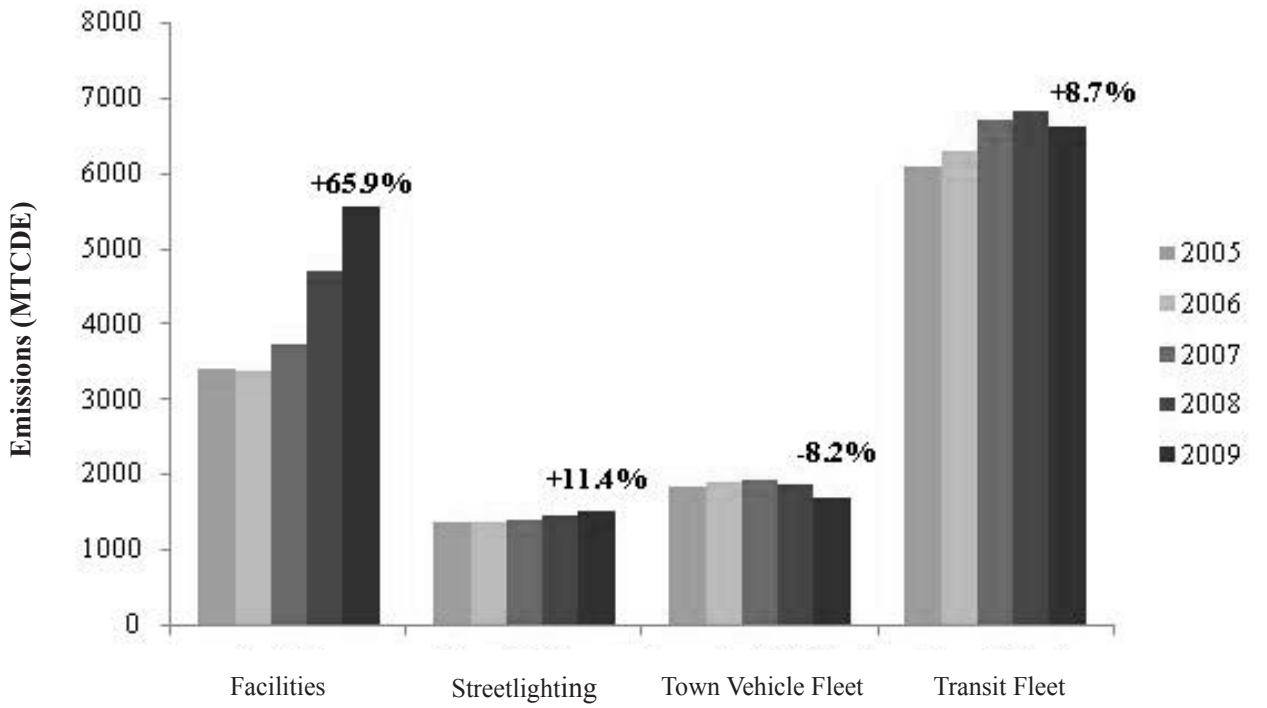

Figure 2: Total Greenhouse Gas Emissions by Sector, 2005 - 2009.

List of Town Activities Inventoried

Among the activities under the Town's operational control, the following activities are classified as *direct emissions*:

- Town vehicle fleet
- Transit vehicle fleet
- Natural gas combustion in town buildings from gas purchased from PSNC Energy
- Fugitive hydrofluorocarbon (HFC) refrigerants from the Town vehicle fleet
- Fugitive HFC refrigerants from the transit vehicle fleet
- Fugitive HFC refrigerants from facilities' HVAC systems

Among the activities under the Town's operational control, the following activities are classified as *indirect emissions from acquired energy*:

- Electricity use in all physical facilities, including those from public works, transit, town hall, the library, parks and recreation, emergency services, and public housing administration, maintenance and unoccupied units
- Electricity use in Town-owned traffic signals
- Electricity use in streetlights within Town limits

A separate report released by a group of undergraduate students at the UNC-Chapel Hill Institute for the Environment have calculated *other indirect emissions* from various sources, including the following:

- Solid waste disposal from municipal facilities
- Emissions credit from recycling at municipal facilities
- Employee commuting
- Employee travel
- Water delivery from Orange Water and Sewer Authority (OWASA) for town operations
- Wastewater treatment from OWASA for town operations

Greenhouse gas emissions from municipal operations have been measured using the procedures and emissions factors published in the ICLEI protocol. "Total emissions" will refer only to direct emissions and emissions from acquired energy; other indirect emissions are outside the Town's operational control and thus are reported separately. Emissions have also been categorized into four activity sectors that constitute operations under control of the municipal government:

- Facilities
- Streetlighting
- Town Vehicle Fleet
- Transit Fleet

Total emissions, as seen in Figure 1, have increased each year from the baseline in 2005. According to the original CRed pledge, emissions reduction goals are stated in terms of emissions per capita based on overall town population. Using population estimates as received from the North Carolina Office of State Budget and Management, the percent change in emissions per capita from 2005 to 2009 increased 10.1% from 0.242 MTCDE/person in 2005 to 0.266 MTCDE/person in 2009. Figure 2 shows the total emissions by sector with percent changes

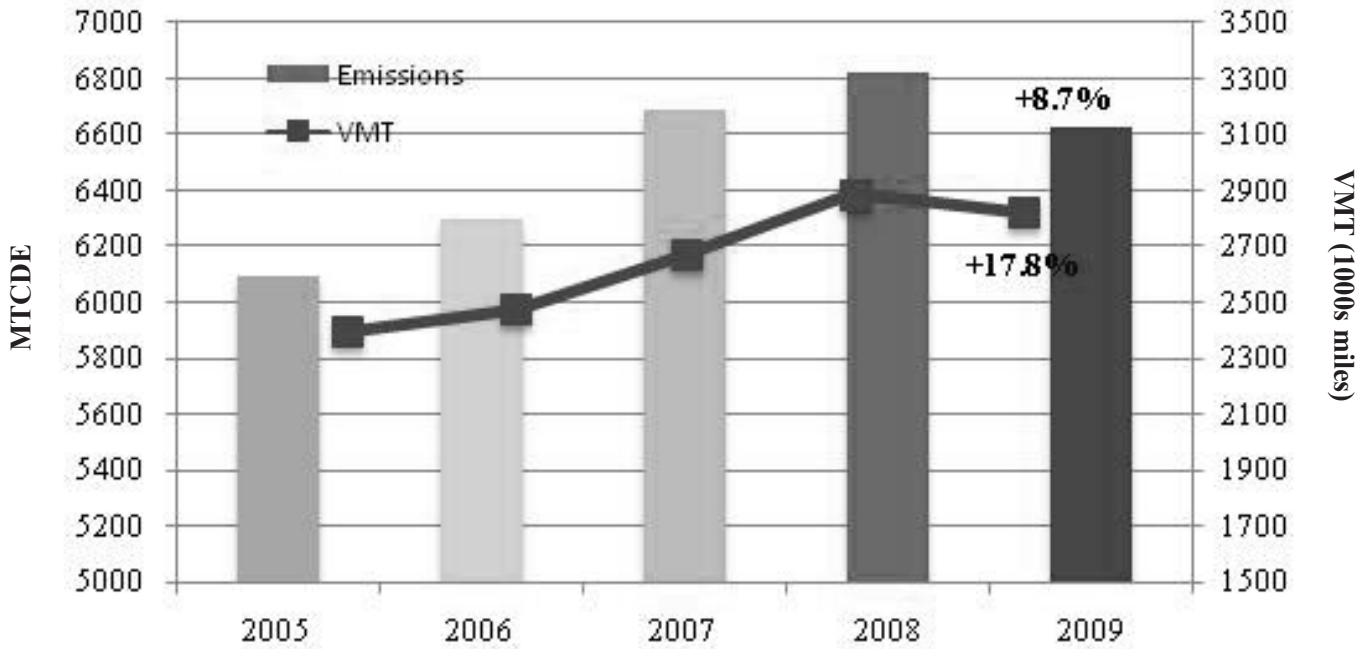

Figure 3: Transit Fleet GHG Emissions and VMT, 2005 - 2009

from 2005 to 2009.[3] The remainder of this article will focus on emissions specifically generated from the Town's transit fleet, followed by some suggestions for greenhouse gas emissions reduction measures and final thoughts.

[Editors' note: For space considerations, only the overall results and those on "Transit Fleet" are published here.]

Results from Transit Fleet Operations

2005 Transit Fleet GHG Emissions	6,095 MTCDE
2009 Transit Fleet GHG Emissions	6,624 MTCDE
Percent Change	+8.7%

Definition

Because some municipalities do not operate a transit agency, ICLEI prompts local governments to report transit fleet activity separate from the vehicle fleet. The transit fleet includes revenue vehicles (buses), demand-response paratransit vehicles, shared-ride vans, support vehicles, and maintenance vehicles.

Emission Sources and Data Availability

Just like the Town's vehicle fleet, transit vehicles cause direct mobile emissions from the combustion of fossil fuels. Unlike the vehicle fleet, the transit fleet utilizes only petroleum-based diesel and gasoline as fuels. There are no ethanol or compressed natural gas (CNG) vehicles in the fleet, and no biodiesel is used.

In addition to the direct tailpipe emissions from mobile combustion, transit also emits fugitive HFC gases from on-board air conditioning system leaks and failures. Because HFC loss is not directly measured, a mass balance between HFC purchases, storage, and safe disposal was used per the ICLEI protocol to determine the amount of fugitive emissions from HFCs.

Analysis of Transit Fleet Results

Transit is a unique sector within municipal operations. Transit is a service that is aggressively promoted as demonstrated by the system transitioning to a "fare free" service in 2002, paid for by local contributions from the students at the University of North Carolina and the towns of Chapel Hill and Carrboro. All other sectors within Chapel Hill's municipal operations have a propensity to conserve energy and cut emissions (energy costs detract from other operating expenditures), but transit operates with an explicit goal of increasing service and ridership. Transit provides an important service to the community and helps displace emissions by reducing the number of private vehicle trips, so there are clear benefits to expanding an already vibrant transit system. At the same time, however, there are ways to reduce the greenhouse gas emissions from current and future transit operations.

In fact, it is imperative to the Town's effort to achieve their 2050 reduction targets that transit emissions be reduced. Transit accounts for over 40% of the Town's total emissions from municipal operations and constitutes the largest of the four measured sectors, as demonstrated earlier in Figure 2. As Table 1 shows, the transit fleet consumes over 73% of all transportation fuels utilized by Town operations. It has been shown that B20 biodiesel use in the Town vehicle fleet has prevented a significant amount of

Fuel Type	Total Gallons	Percent of Total
Transit Fleet Diesel	590,802	68.0%
Town Fleet B20 Biodiesel	92,849	10.7%
Town Fleet Gasoline	91,271	10.5%
Town Fleet E85	46,960	5.4%
Transit Fleet Gasoline	44,536	5.1%
Town Fleet CNG	1,956	0.2%

Table 1: Transportation Fuel Use for Municipal Operations in 2009.

emissions from occurring, but the transit fleet uses nearly half a million more gallons of diesel fuel than the Town vehicle fleet. From the 2005 baseline, the transit sector has seen increasing annual emission rates until a decrease from 2008 to 2009 (Figure 3). The decrease can be attributed to the service of 14 hybrid buses as well as a 2.2% decrease in the vehicle miles traveled (VMTs). From 2005 to 2009, transit buses have substantially increased in fuel efficiency from 3.6 to 3.9 miles per gallon. Any improvement in fuel efficiency for very low efficiency vehicles corresponds to a large savings in fuel use.

Transit Credit from Displaced Community Emissions

Transit provides a number of benefits to a community including affordable mobility, congestion management, and support of transit intensive neighborhoods such as central business districts and university campuses. Mass transit is able to achieve energy efficiencies unattainable by the automobile and road network, and energy savings translate to greenhouse gas avoidance.

It is easy to see the effects of transit in a place like New York City, but a bit more difficult in a suburban setting like Chapel Hill. The American Public Transportation Association (APTA) has published a protocol to quantify the energy and greenhouse gas savings provided by a transit agency to a community. There are three main sources of community-wide energy savings and emissions displacement that are addressed in the protocol:

- *Mode Shift*: the direct displacement of emissions from those transit riders who otherwise would be using some form of private motorized travel
- *Congestion Relief*: the direct effects of displaced private automobile travel that prevents further congestion and wasted fuel from idling in traffic that, without transit, would be even worse than it currently is
- *Land-use Multiplier*: the indirect impacts of transit on land-use patterns that allow for development that reduces trip lengths, facilitates bicycle and pedestrian travel, allows for multiple trips to be combined into single trips, and decreases vehicle ownership rates

These displaced emissions are not actual emissions that have been reduced, but rather emissions that are prevented from ever occurring in the first place. The ICLEI protocol does not include guidelines for reporting this data, but it has been included in this report as an information item.

[Editors' note: For more precise methodology and explanation of transit credit calculations, see Appendix B of the original document.]

Greenhouse Gas Reduction Options

This inventory would be incomplete if it did not include at least a brief analysis of reduction options available to the Town. ICLEI identifies the development of a Local Climate Action Plan as Milestone 3 in its Five Milestones for Climate Mitigation. This brief section does not in any way attempt to replace the Local Climate Action Plan called for as Milestone 3. The necessity to closely examine all reduction options and create a long-term strategy to achieve greenhouse gas reductions still exists, but this section hopes to introduce a broad array of available options and to quantify those options to convey their respective effectiveness. Many reduction options exist beyond the following lists and of all degrees of magnitudes, small to large. This report includes reduction options that are organized into three categories – Clear Actions, Calculated Moves, and Long-Term Possibilities – based on shared characteristics.

[Editors' note: The text sections on the calculated moves and long-term possibilities for greenhouse gas reduction were cut due to space considerations. However, the relevant tables (Tables 3 and 4) are included to the right.]

Clear Actions are action items with no significant barriers to implementation and immediate financial benefits for enacting these measures (Table 2). Chapel Hill Transit has already begun implementing measures that have thus far increased by 7% the fuel efficiency of several test buses. Block grants for Town-wide facility upgrades have also been approved to increase the efficiency of facilities and are expected to save the town over 500 MTCDE per year as well as reduce energy costs. From 2008 to 2009, the Town vehicle fleet reduced its VMTs by over 5%, which contributed to the 10% overall decrease in Town fleet emissions from 2008 to 2009. If policies were implemented that reduced the VMTs of the fleet by an additional 10%, Town vehicle fleet emissions could decrease, with no other additional actions, to 18% below their 2005 levels. If 10 hybrid vehicles were purchased for a marginally higher cost than the planned vehicle replacements, an additional 2% reduction in Town vehicle fleet emissions could be realized.

Final Thoughts

As this inventory has shown, reducing greenhouse gas emissions can be a difficult, yet achievable, endeavor.

GHG Reduction Options with Estimated Benefits and Costs

Clear Reduction Action	MTCDE Reduction Estimate	Cost Range
Transit: 7% fuel efficiency improvement in buses	394	Medium
Facilities: Energy block grant municipal facility upgrades - HVAC	367	Low
Town Fleet: Reduce VMTs by 10%	183	Low
Facilities: Energy block grant municipal facility upgrades - Lighting	149	Low
Facilities: Park and Ride lots - LED retrofit	88	Medium
Town Fleet: Add 10 hybrid vehicles to town fleet by replacement	33	Marginal
Traffic Signals: Rosemary St. LED retrofit	14	Very Low
Facilities: Consider carbon impacts of expansion	*n/a*	No Cost

Table 2: Clear Action Reduction Opportunities

Calculated Moves Reduction Action	MTCDE Reduction Estimate	Cost Range
Transit: Adopt B20 use in place of diesel	1,129	Medium
Electricity: 12.5% "greener" electricity source	695	High
Town Fleet: Increase efficiency of light duty vehicles to 20 MPG average	417	High
Facilities: Energy block grant municipal facility upgrades - Lighting	149	Low
Streetlights: Downsizing HPS wattage	261	Low
Streetlights: Replacement of MV with HPS/MH	192	Low

Table 3: Calculated Moves Reduction Opportunities

Long-Term Reduction Action	MTCDE Reduction Estimate	Cost Range
Town Fleet: Full conversion from B20 to B50	256	Medium - High
Town Fleet: Replace passenger vehicles with EVs	339	Medium - High
Town Fleet: Replace all gasoline light duty trucks with E85	464	Medium
Town Fleet: Full conversion from B50 to B90	342	High
Facilities: From 12.5% to 50% greener electricity source	1,535	Very High
Streetlights: Full LED retrofit	718	High
Streetlights: From 12.5% to 50% greener electricity source (with LEDs in place)	269	Very High
Transit: Full hybrid bus fleet (with B20)	879	High
Transit: Adopt B50 use in place of B20	1,363	Medium - High
Streetlights: Adopt B90 use in place of B50	1,818	Medium - High

Table 4: Long-Term Reduction Opportunities

Areas in which the Town has established policies and implemented energy-saving practices have seen success in reducing emissions, such as the Green Fleets Policy within the Town vehicle fleet, hybrid bus purchases within its transit fleet, and LED traffic signal retrofits within the streetlighting sector. However, it takes a continual, widespread, concerted effort to accomplish the reduction targets.

There are many emerging technologies today and hopes of further innovations that seek to reduce the carbon-intensity of our energy sources. As important as technological advances are, behavioral changes could also factor into achieving significant greenhouse gas reductions in the form of fewer miles placed on town vehicles and more energy-efficient building management. Community-wide behavioral changes can also contribute to reduced municipal emissions. State policies, such as the Renewable Energy and Energy Efficiency Portfolio Standard that comes into full effect in 2021 and calls for 12.5% of the state's electricity to be from clean, renewable sources, are also important in achieving carbon reductions. If future technological improvements and voluntary behavioral changes delay too long in reversing climate catastrophe, federal and global carbon pricing mechanisms could encourage our society to quickly wean itself off of carbon-intensive energy.

As national and state political action continues to develop regarding climate change, Chapel Hill should position itself to stay ahead of the carbon curve. By conducting thorough annual inventories, developing and implementing a climate action plan, and closely monitoring all progress in its own carbon reduction, Chapel Hill has the opportunity to be the leading municipality in the state for climate change mitigation. A vibrant, resilient future is possible, and hopefully Chapel Hill charts that path forward.

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Endnotes

[1] ICLEI is a membership association of local governments dedicated to climate protection and sustainable development by providing climate protection analysis tools and assistance to local governments.

[2] There are five "milestones" to achieving climate mitigation as outlined by ICLEI: 1) Conduct a baseline emissions inventory and forecast; 2) Adopt an emissions reduction target; 3) Develop a local climate action plan; 4) Implement policies and measures; and 5) Monitor and verify results.

[3] The large percent change increase in "facilities" is likely the result of the higher number of facilities in 2009, rather than increasing inefficiencies, per se.